The combination of the 4830-MHz and 14.5-GHz formaldehyde lines is a sensitive and useful diagnostic of the density in the emitting gas. Extragalactic formaldehyde megamaser emission and absorption are found in a growing number of galaxies. Since formaldehyde is a good tracer of intermediate- to high-density gas, this line is very important for the study of the molecular structure of other galaxies.

The spectral band around 5 GHz has been one of the most widely used frequency ranges in radio astronomy during the last decade. Astronomers have made use of this frequency range in order to study the detailed brightness distributions of both galactic and extragalactic objects. Detailed radio maps of interstellar ionized hydrogen clouds and supernova remnants have assisted our understanding of the nature of such celestial objects. These radio maps define the extent and detailed morphology of radio sources and enable us to make conclusions concerning their structures and dynamics and to derive physical parameters of the sources such as their total masses.

Heavy use has been made of the radio astronomy band at 5 GHz for VLBI observations. Angular resolutions of 0.0003 arc seconds have been achieved with intercontinental baselines, and many countries (Australia, Canada, Great Britain, The Netherlands, South Africa, Spain, Sweden, U.S.S.R., and Germany) have collaborated in this effort. From such studies, astronomers are finding that quasars are composed of intricate structures with many strong localized sources of radio emission.

The technique of VLBI has many other practical applications, such as studies of continental drift, the rotation rate of the earth, polar wandering, latitude determination, spacecraft navigation, and earthquake studies. Such experiments are able to determine intercontinental distances with accuracies of a few centimeters.

International VLBI observations make heavy use of almost all of the radio astronomy bands. At the higher frequencies, the angular resolution is even better than at 5 GHz, and increased emphasis on the bands near 15 GHz and 22 GHz is expected.

Comments

21. 8400-8500 MHz: This band is widely used for studies in conjunction with, and in support of, geodetics and Space Research (space to earth) experiments. Common use of this band for radio astronomy observations using VLBI and for space science allows the full and effective use of costly facilities built for space research and communications and for radio astronomy. This band should be allocated to the Radio Astronomy Service on a secondary shared basis.

22. 10.60-10.70 GHz: The committee urges worldwide, exclusive passive allocation for this continuum band. The worldwide, exclusive allocation of the 10.6-10.7 GHz band to passive services also would benefit global passive remote sensing of precipitation. Many rainfall estimation techniques currently require the use of this frequency band.

23. 14.47-14.50 GHz: This band is important for study of one of the formaldehyde (H_2CO) lines and, in conjunction with the 4.83 GHz formaldehyde line, is a sensitive diagnostic for the density of the emitting regions (see Comments 18 above and 24 below).

24. 15.35-15.40 GHz: While no change in status is needed in this worldwide exclusive allocation, it is noted that it would be somewhat more desirable to substitute in place of this band a 1- to 2-percent continuum band roughly centered on the formaldehyde line at 14.4885 GHz. This new band would

still be centered between the 10.6- and 23.8-GHz continuum bands while affording excellent protection for the 14.4885-GHz line.

25. <u>18.6-18.8 GHz</u>: This transmission window is used for rainfall measurement by passive earth exploration satellites. Primary allocation in Region 2 should be extended to all three regions.

<u>Justification (21, 22, 23, 24, 25)</u>

The band at 10- to 15-GHz provides some of the best angular resolutions (~2 arc minutes) using many large and accurate radio telescopes. Many of the nonthermal synchrotron sources are just detectable at higher frequencies, and this frequency range gives us observational information at the highest frequency where such sources can be detected reliably. This high-frequency range is also extremely important for monitoring the intensity variability of the quasars. These objects, which could be the most distant celestial objects that astronomers can detect, and which produce surprisingly large amounts of energy, have been found to vary in intensity with periods of weeks and months. Such observations lead us to estimate the sizes of these sources, which turn out to be very small for the amount of energy they produce. The variability of quasars (and some peculiar galaxies) is more pronounced at higher frequencies, and observations at these frequencies facilitate the discovery and the monitoring of these events. The energy emitted during any one such burst from a quasar is equivalent to the complete destruction of a few hundred million stars in a period of a few weeks or months. Astronomers do not yet understand the fundamental physics that can produce such events. Observations of the size and variability of these sources are the primary means that can be used to determine their nature. These observations are now best performed in the frequency range 10 to 15 GHz.

The small sizes of the quasars are revealed from the VLBI observations mentioned above. Such

Justification (26, 27)

The two narrow bands, 22.21-22.50 GHz and 23.6-24.0 GHz, are important primarily because they include the H_2O and NH_3 molecular lines, respectively, which have been detected in the interstellar medium both in our galaxy and other galaxies.

The discovery in 1968 of the H_2O molecule in interstellar space presented many new and interesting puzzles. These lines are extremely intense and variable; consequently they are occasionally the most intense radio sources in the sky (at 22.2 GHz) other than the sun and the moon. It was soon discovered that the intensities of these lines are highly variable, that the sizes of the H_2O sources are extremely small (a few astronomical units), and that the lines are highly polarized. Interstellar H_2O maser action is necessary to explain such observations. Such sources seem to be similar to the OH sources discussed above. With high-frequency (hence high-velocity) resolution, H_2O sources have been observed to show multiple components, each one with a slightly different velocity in the line of sight. Astronomers believe that such molecular clouds are related to the formation of protostars. VLBI observations at 22.2 GHz provide valuable information on the sizes and structure of the H_2O maser sources.

The discovery of NH_3 (ammonia) in interstellar space presented an example of a molecule radiating thermally. Maser action is not necessary to explain the NH_3 observations. The distribution of NH_3 clouds in the galaxy and their relation to the other molecules that have been discovered is of great interest. The analysis of the NH_3 line observations enables us to deduce accurately the temperature of the interstellar medium where these clouds exist. They also assist us (indirectly) in deducing the concentration and abundance of molecular hydrogen (H_2), which cannot be observed at radio wavelengths since it produces no radio lines.

Comments

28. 31.3-31.8 GHz: The basic present allocation (31.3-31.8 GHz) is nearly the desired 2-percent bandwidth. This band is also used for passive remote sensing of terrestrial cloud water and precipitation.

29. 36-37 GHz: This transmission window is useful for passive remote sensing of terrestrial cloud water and precipitation, primarily as an alternative to 31.3-31.8 GHz.

Justification (28, 29)

The frequency region from 31.2 to 37.5 GHz is the first atmospheric window in the millimeter radio region where ground-based observations can be made. On either side of this frequency band, water and oxygen molecules in the earth's atmosphere attenuate the incoming radiation, although only the O_2 absorption beginning about 50 GHz is sufficiently strong to render observations impossible. This spectral region contains lines of CH_3N, a molecule that is becoming of increasing importance as more long-chain molecules of the form HC_xN ($x = 1, 3, 5, 7, 9 \ldots$) are found. The region has also been useful in defining the high-frequency continuum spectra of galactic and extragalactic objects. It is anticipated that the use of this band will be greatly increased as large telescopes become operational at these frequencies. For instance, the new 100-meter Green Bank Telescope (GBT) is expected to operate at frequencies as high as that of this band.

Comments

30. 42.5-43.5 GHz: This band encompasses the vibrational transitions of SiO. All of these transitions have been detected as maser emission from the regions of late-type stars.

31. 48.94-49.04 GHz: This band contains the lines of CS and its isotopes. They have been detected in molecular clouds. Since CS is a good high-density tracer, whereas CO is a low-density tracer, CS is extremely important as a diagnostic for the molecular material in other galaxies and in particular the active nuclei and starburst galaxies.

32. 50.2-50.4 and 51.4-59.0 GHz: Passive remote sensing instruments measure the earth's atmospheric temperature profiles using oxygen transitions within these bands.

33. 60-61.5 GHz: This band has potential uses in passive remote sensing of mesospheric temperature profiles.

34. 64-66 GHz: This band is used for passive remote sensing of the atmosphere of the earth from space. In particular, it is valuable for measuring atmospheric temperature profiles using oxygen transition lines within these bands.

Justification (30, 31, 32, 33, 34)

The allocated band at 42.5- to 43.5-GHz provides protection for observations of the SiO molecule. The lines of SiO indicate maser emission, the mechanism of which is not understood but extends over a wide range of excitation in the SiO molecule.

The lines of CS and its less common isotopes, $C^{33}S$, $C^{34}S$, and ^{13}CS, have been shown to be constituents of both giant molecular clouds and cool dark clouds. Since the $J = 1 \rightarrow 0$ transition arises in the lowest possible energy levels of CS, this molecule will become increasingly important in probing cool clouds. Other molecules with detected transitions in this frequency range include H_2CO, CH_3OH, and OCS.

Comments

35. 86-92 GHz: This is a wide and useful band near an atmospheric absorption minimum. At least 72 spectral lines fall in this band and are thus already protected through this allocation. This atmospheric transmission window is also useful for remote sensing of terrestrial clouds and precipitation, and provides one of the most useful microwave channels for this purpose.

only one showing strong maser emission in an excited vibrational state. HCN, HCO, and HCO^+ are vitally necessary participants in the ion-molecule reactions believed to be key in the formation of many other molecules in the interstellar gas. Furthermore, some molecules have several isotopic species in this range so that isotopic abundance ratios and optical depth effects can be studied. As an example, the basic molecule HCN has the isotopic species $H^{12}C^{14}N$, $H^{3}C^{14}N$, and $H^{12}C^{15}N$ in the 86-92 GHz range, and all have been observed in the interstellar gas. It is clear that this region of the millimeter spectrum will remain one of the most used for radio astronomy.

Comments

37. 105-116 GHz: Carbon monoxide (CO) is among the most important of the interstellar molecules. The primary line is at 115.271 GHz, and important isotopic variations of the molecule have lines at somewhat lower frequencies; for example, $^{13}C^{16}O$ has its line at 110.2 GHz. Furthermore, the important diatomic molecules CN and CS and isotopic variations of these molecules fall in the same general region of the spectrum. The upper portion of this band is needed for passive remote sensing of atmospheric temperature profiles.

38. 116-126 GHz: Passive remote-sensing instruments measure the earth's atmospheric temperature profiles using the oxygen transition at the center of this band at 118.75 GHz. Additional protection is desirable.

Justification (37, 38)

The discovery of interstellar CO at 115.271 GHz has been of fundamental significance for the subject of astrochemistry. This is primarily because CO is a relatively stable molecule compared with other molecules discovered in the interstellar medium, and also because CO seems to be very abundant and exists almost everywhere in the plane of our galaxy as well as in a number of other galaxies. Studies have yielded new information on the distribution of gas in spiral galaxies. Allowance for Doppler shifts characteristic of nearby and even distant galaxies is essential for adequate protection of radio spectral lines.

Because the CO molecule is so ubiquitous, and therefore present under nearly all physical and chemical conditions, its emission is the principal tool available to astronomers today for the study of the star forming gas in the Milky Way Galaxy, and even in quite distant galaxies. CO studies tell us about

40. <u>182-185 GHz</u>: This band, shared with passive space research, is important for remote sensing studies of water vapor.

<u>Justification (39, 40)</u>

Allocations at 164-168 GHz and 182-185 GHz are important for radio astronomy and other passive services. Water, an important constituent of interstellar clouds as well as of the terrestrial atmosphere, has only two low-lying radio-frequency lines, 22.235 GHz and 183.310 GHz. Both of these water lines are used for radio astronomy and passive sensing. Like the 22 GHz-line, the 183-GHz line is produced by maser activity in the interstellar medium and is observed near hot young stars. However, the line is strongly attenuated by the earth's atmosphere, and so the observations are easily susceptible to interference.

<u>Comments</u>

41. <u>217-231 GHz</u>: This is an important primary allocation, shared with space research (passive). This band contains the second available rotational line of carbon monoxide ($^{12}C^{16}O$), together with its isotopic variants $^{13}C^{16}O$ and $^{12}C^{18}O$. These are very strong and important lines both within our galaxy and in distant galaxies. In combination with the first lines in the 106-116 GHz band, they permit the determination of the physical characteristics of the gas within the galaxies. The coverage for $^{12}C^{16}O$ extends to galaxies at velocities of 2000 km/s, but should be much greater to give protection to future work to learn about the structure and evolution of much more distant galaxies.

Besides CO lines, there are many lines of complex molecules observable in this band and neighboring bands. Each complex molecule may have many lines spread throughout the radio spectrum, so it is not practical to request protection for the various individual frequencies. Rather, in analogy with the protection given for continuum studies, the requirement is for a number of relatively wide, well-protected bands, placed at strategic intervals throughout the spectrum.

<u>Justification (41)</u>

The frequency band at 217-231 GHz is in the center of the highest spectral region at millimeter wavelengths where there is a useful atmospheric window. On each side of the 200-300 GHz region, atmospheric H_2O absorption makes ground-based observations difficult or impossible.

Radio astronomy is extremely active in this region of the spectrum because of the unique insights spectroscopic studies provide into star formation, interstellar chemistry, the late stages of stellar evolution, and the chemical composition of the Milky Way and other galaxies. The most important line in this band is that of carbon monoxide, which is essential to observe over as wide a spectral range as possible in order to study the kinematics and evolution of distant galaxies. In addition to carbon monoxide, a large number of lines belonging to many interstellar species have recently been detected in this band and in neighboring regions of the spectrum. In the range from 208 to 260 GHz, about 1000 lines are now known. Several new telescopes are being constructed or have recently been completed to work in the range from 100 to 300 GHz and above, in the United States, Europe, and Chile. This spectral region is one of rapidly increasing activity in radio astronomy.

This band also provides a continuum window near the peak of the 2.7 K cosmic background radiation. This radiation, emitted when the universe was only about 100,000 years old, is one of the most significant discoveries in the study of cosmology. Further detailed studies of its properties will yield background radiation field and the rotation and symmetry of the universe. Because of the low intensity of the background radiation, accurate measurement of its distribution must be made from high-altitude aircraft, balloons, and spacecraft in an environment free from interference.

VI. THE PROTECTION OF RADIO ASTRONOMY OBSERVATIONS IN THE SHIELDED ZONE OF THE MOON

Future radio astronomy observations made from telescopes in the shielded zone of the moon will need to be protected. The reasons for this are discussed in CCIR Recommendation 479-1, "Protection of Frequencies for Radioastronomical Measurements in the Shielded Zone of the Moon" (see Appendix). The Committee on Radio Frequencies has been concerned for a number of years with protecting radio astronomy observations in this zone.

Along with discussions of establishing a lunar observatory in the next century (see, for example, *The Decade of Discovery in Astronomy and Astrophysics*, National Academy Press, Washington, D.C., 1991), it is prudent for scientists to prepare for actions that may be needed to protect passive observations. The concept of a Lunar Quiet Zone has been studied and advanced as a valuable international resource for radio astronomers and for other scientists who conduct passive observations of the universe.

APPENDIX

Protection of Frequencies for Radioastronomical Measurements in the Shielded Zone of the Moon

CCIR Recommendation 479-1 (International Telecommunications Union, Geneva)

"The CCIR,

CONSIDERING

"(a) that some radioastronomical and other scientific experiments are difficult, and in certain cases impossible, to carry out on the surface of the Earth because of tropospheric and ionospheric absorption, scintillation, and radio interference;

"(b) that radioastronomical discoveries resulting from limited observations from spacecraft above the atmosphere of the Earth reveal unexpected new astronomical phenomena;

"(c) that further developments will enable experiments to be carried out in the relatively quiet environment in the shielded zone of the Moon;

"(d) that, in addition to the establishment of line-of-sight communication links for scientific and other purposes between the Earth and spacecraft, it may be necessary to establish links between stations on the far side of the Moon and other stations on or visible from the Earth;

"(e) that the shielded zone of the Moon is free from terrestrial radiation at all radio frequencies;

"(f) that Recommendation No. Spa 2-8 of the Radio Regulations expresses the desirability of maintaining the shielded area of the Moon as an area of maximum value for observations by the Radioastronomy Service and by passive space research and consequently as free as possible from transmissions;

"(g) that the same Recommendation also invited the CCIR to study the frequency bands most suitable for radioastronomy observations on the shielded area of the Moon and work out Recommendations concerning these bands as well as criteria for their application and protection;

"(h) that Earth satellites with high apogees, deep-space probes and transmitters located on the Moon may each illuminate the shielded zone;

"(i) that Report 539-1 contains preliminary guidelines on the use of the frequency spectrum in the shielded zone of the Moon,

"UNANIMOUSLY RECOMMENDS

"1. that in planning the use of the radio spectrum, both nationally and internationally, account be taken of the need to provide for radioastronomy observations in the shielded zone of the Moon;

"2. that, in taking account of such a need, special attention should be given to those frequency bands in which observations are difficult or impossible from the surface of the Earth;

"3. that the frequency spectrum should be used in the shielded zone of the Moon in keeping with the preliminary guidelines contained in Report 539-1.

"4. that in the frequency bands which would be considered for joint use by active and passive space stations in the shielded zone of the Moon, radioastronomy observations should be protected from harmful interference. To this end appropriate discussions between concerned administrations may be conducted."

ATTACHMENT 2

BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's	)	
Rules with regard to the	)	GEN Docket No. 90-357
Establishment and Regulation of	)	
New Digital Audio Radio Services	)	

COMMENTS OF CORNELL UNIVERSITY

I. Introduction

Cornell University ("Cornell"), which operates the Arecibo Observatory ("the Observatory") under the terms of a cooperative agreement with the National Science Foundation, hereby offers its Comments on the above-captioned matter.

In its Notice of Proposed Rulemaking and Further Notice of Inquiry ("NPRM"), released November 6, 1992, the Commission proposes to allocate spectrum domestically for satellite digital audio services ("DARS") in the 2310-2360 MHz band. The Commission notes that the proposed allocation is based on the international allocation adopted for the United States by the 1992 World Administrative Radio Conference ("WARC-92").

As explained below, Cornell is concerned about the interference that DARS emissions could cause to planetary radar studies being conducted at the Observatory at 2380 MHz. This NPRM comes at a time when the planetary radar capabilities at Arecibo Observatory are being upgraded at a significant cost to the taxpayer. Radar echos of planetary surfaces contain unique information about the surface properties, the orbit, and the size of the planetary object. This radar technique has been successfully applied to all nearby planets as well as comets and asteroids.

II. Radar Studies at the Observatory

The Arecibo Observatory, which is part of the National Astronomy and Ionosphere Center (a federally owned national research center) is the largest radio/radar telescope in the world. The replacement cost today is estimated at $100 million. The annual operating budget, supplied by the NSF and supplemented for planetary radar research by NASA, is currently $7.5 million.

A new Gregorian Upgrade initiative aimed at upgrading the telescope for higher sensitivity and lower system temperatures is presently underway and is being funded by the NSF and NASA for $22.8 million. The Upgrade program centers on the replacement of one of the two antenna/receiver houses by a Gregorian subreflector system allowing operation from 300 MHz to 10 GHz. This subreflector system, serving as the secondary and tertiary in the optics, will be housed in an 83 ft diameter space frame. The Arecibo Observatory is by far the largest aperture radio/radar telescope in the world and plays a leading role as a versatile research instrument in radiophysics.

Planetary studies currently make use of a 450 kW S-band transmitter which, with the reflector's forward gain of 71 dB, is the world's most powerful radar. Achievements in this field include detailed maps of Venus, the recent discovery of ice caps on Mercury, and images of the large icy satellites of Jupiter. The potential danger to the Earth posed by small asteroids has recently received considerable publicity.

III. DARS Sideband Emissions Must Be Sufficiently Filtered In Order To Prevent Interference to Radar Astronomy Operations in the 2370-2390 MHz band.

Interference in the 2370-2390 MHz band can be caused by DARS transmissions from geostationary satellites covering the continental US. Such emissions may be attenuated by at least 7 dB in Puerto Rico because the island lies sufficiently far from the center of the footprint. Nevertheless, Cornell is concerned that DARS sideband emissions from any of the frequency channels in the DARS band may spill into the band used for planetary radar astronomy. The planetary radar system is used in a distinct transmit-receive mode of coded pulsetrain signals and DARS sideband emissions could interfere with the detection and decoding of the returning signal from the planetary object.

Sideband emission, if unfiltered, from the upper frequency DARS channels will add a few percent to the system temperature over the 2370-2390 MHz band of the Arecibo radar system and can potentially result in a small but significant decrease in sensitivity for the system. A deterministic component within the unfiltered DARS sideband emission could be very harmful for planetary radar observations. Such spectral structure could mimic the type of information to be received from the planetary surface and will be particularly harmful in terms of detecting weak signals from comets and asteroids. Suppression of at least 60 dB beyond 10 MHz above the DARS frequency channel edge would be required to alleviate these harmful effects. Circularly polarized DARS emissions may further affect the essential polarization information in the planetary data and may inhibit a proper interpretation of this information.

Accordingly, if and when the Commission prepares technical and service rules for DARS, Cornell requests that such rules include provisions for filtering DARS emissions in order to minimize emissions in the band used for planetary radar.

IV. The Proposed DARS 2310-2360 MHz Band Must Not Be Extended Beyond the Proposed 2360 MHz Band Edge.

The spectrum requests made by the applicants add up to more than the 50 MHz of spectrum available in the DARS band. The Commission should not extend the

DARS band upward. The planetary radar system at Arecibo Observatory uses the 2370-2390 MHz band. Considering the power of the DARS broadcasting systems a 10 MHz space between the band is needed to protect the planetary radar system. Even with common filtering techniques, the roll-off is sufficiently small so as not to allow a closer spacing between the two bands.

Respectfully submitted,

CORNELL UNIVERSITY

By: ______________________

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January 29, 1993

ATTACHMENT 3

the existing allocation at 23.00-23.55 GHz for the IRIDIUM system inter-satellite links. No other applicant for an MSS/RDSS system has proposed use of the inter-satellite service in this band or anywhere else.

In view of NASA's intent to use the 22.55-23.55 GHz band for its TDRSS-II system, Motorola and NASA had several informal discussions on methods of sharing this inter-satellite service allocation. NASA subsequently sent Motorola a letter recognizing that Motorola plans to use the sub-band 23.18-23.38 GHz for interconnecting the IRIDIUM constellation of LEO satellite. (See MSSAC/IWG-3-10). NASA's letter also stated NASA's expectation that any future applications, for this purpose, will be licensed to use the 24.45-24.75 GHz band which will be available as of October 12, 1993, and confirmed that the 23.18-23.38 GHz band is the optimal place in the 22.55-23.55 GHz bands for the use proposed by Motorola.

4.5.1.2 **Future Inter-satellite Link Requirements**

The discussion in Working Group-3 clarified that LEO inter-satellite link use of the frequencies at 23.18-23.38 GHz would be

Broadcasting Satellite Service allocation at 22.55-23.00 in Regions 2 and 3.

4.5.3 Sharing with Fixed and Mobile

Finally, a question was raised regarding the necessity of sharing criteria between the fixed and mobile and inter-satellite link services. It was concluded that given the natural isolation between such services new criteria would not be necessary. Statements on this matter are contained in section 4.8 of the CCIR Report on the Technical and Operational bases for the World Administrative Radio Conference 1992 (See Attachment 4.2 - B). In addition WARC-92 in RR 2577-2580 adopted PFD limit (See Appendix 4.2-3 for the 22.55-23.55 GHz allocation which is met by the IRIDIUM system as shown in Figure 4.5-2.

4.5.4 Protection of Radio Astronomy

At present, only Motorola proposes to employ inter-satellite links within any portion of the ISS band 22.55-23.55 GHz, which also contains two spectral lines of interest to radio astronomy, 22.81-22.86 GHz and 23.07-23.12 GHz.

Motorola proposes to employ the band segment 23.18-23.38 GHz, which is sufficiently far removed from these spectral lines so that interference would be unlikely.

If, in the future, an MSS/RDSS operator proposes to use a band segment containing those spectral lines, the possibility of interference would have to be considered.

The PFDs reaching the surface of the Earth proposed by participants on the Working Group vary between -115 dBW/m2/MHz and -105 dBW/m2/MHz, depending on the angle of arrival.

Since the level at which harmful interference could be caused to these spectral line observations given in CCIR Report 224 is -216 dBW/m2/Hz, a reduction on the order of 41 to 51 dB would be required to protect radio astronomy sites from ISS signals reaching the surface of the Earth, depending on the spectral shape of the interfering signal.

A combination of satellite antenna discrimination and the use of ISS links which do not pass close to the limb of the Earth can provide a measure of isolation.

4.5.5 Summary of Inter-satellite Links

The issues addressed include use of inter-satellite link allocations, sharing criteria, and future use of inter-satellite link allocations. The analyses indicate that the use of the inter-satellite allocation at 23.18-23.38 GHz band was compatible with NASA's and Radio Astronomy's use of the 22.55-23.55 GHz allocations, and the fixed service in the same allocations would be protected. However, it was indicated that NASA would prefer that further MSS applications proposing to use the inter-satellite service should look to the 24.45-24.75 GHz bands for this purpose.

Several new rules are proposed to provide for the inter-satellite service frequencies, coordination with government agencies, and certain sharing criteria.

5.0 Rules and Recommendations

The Working Group recommends that the Commission take account of the analyses that appear in this report and the working group reports attached hereto and act on the rules and recommendations which have received consensus support of the full Committee. A compilation of recommended rule changes appears in section 5.1. Recommendations other than specific rule changes are summarized in section 5.2.

5.1 Rules

5.1.3 Feeder Link and Inter-Satellite link